



**U.S. Environmental Protection Agency  
Region 2**

SDMS Document



112841



# **Response Action Contract**

**DRAFT FINAL  
TECHNICAL IMPRACTICABILITY EVALUATION FOR  
GROUNDWATER ALTERNATIVE GW3 - SOURCE AREA  
CONTAINMENT VIA HYDRAULIC CONTROL/  
TREATMENT/DISCHARGE AND ALTERNATIVE GW4 -  
PLUME REMEDIATION VIA  
EXTRACTION/TREATMENT/DISCHARGE**

**FOR THE  
CHEMICAL INSECTICIDE CORPORATION SITE  
EDISON, NEW JERSEY**

**JULY 2003**

**Contract No: 68-W-98-214**

**FOSTER  WHEELER**

**FOSTER WHEELER ENVIRONMENTAL CORPORATION**

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EPA WORK ASSIGNMENT NUMBER: 106-RICO-0294  
EPA CONTRACT NUMBER: 68-W-98-214  
FOSTER WHEELER ENVIRONMENTAL CORPORATION  
RAC II PROGRAM

DRAFT FINAL  
TECHNICAL IMPRACTICABILITY EVALUATION FOR GROUNDWATER  
ALTERNATIVE GW3 - SOURCE AREA CONTAINMENT  
VIA HYDRAULIC CONTROL/TREATMENT/DISCHARGE AND  
ALTERNATIVE GW4 - PLUME REMEDIATION  
VIA EXTRACTION/TREATMENT/DISCHARGE

FOR THE  
CHEMICAL INSECTICIDE CORPORATION SITE  
EDISON, NEW JERSEY

JULY 2003

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# FOSTER WHEELER ENVIRONMENTAL CORPORATION

28 July 2003  
RACH-2003-149

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**SUBJECT: USEPA RAC II CONTRACT NUMBER: 68-W-98-214  
WORK ASSIGNMENT NUMBER: 106-RICO-0294  
CHEMICAL INSECTICIDE CORPORATION RI/FS  
DRAFT FINAL TECHNICAL IMPRACTICABILITY EVALUATION  
FOR GROUNDWATER**

Dear Mr. Keveney:

Foster Wheeler Environmental Corporation is pleased to provide 13 copies of the subject document. If you should have any questions or require additional information, please do not hesitate to contact me at (973) 630-8124.

Sincerely,

Douglas K. Stout  
RAC II CIC Project Manager

DKS/dks

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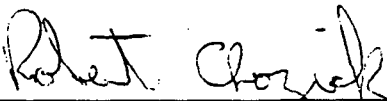
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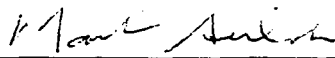
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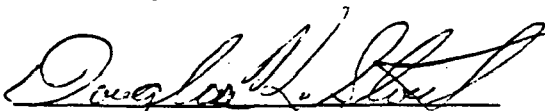
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## 1.0 INTRODUCTION

This technical impracticability (TI) evaluation for the Chemical Insecticide Corporation (CIC) site, Operable Unit 4 (OU-4), has been prepared in response to Work Assignment Number 106-RICO-0294, issued by the United States Environmental Protection Agency (EPA) under RAC II Contract Number 68-W-98-214. The TI evaluation has been prepared in accordance with "Guidance for Evaluating the Technical Impracticability of Ground-Water Restoration" (EPA, 1993).

The purpose of this TI evaluation is to evaluate the technical impracticability of achieving groundwater Applicable or Relevant and Appropriate Requirements (ARARs) at the CIC site via the implementation of any of the active groundwater remedial alternatives considered in the FS report, including Alternative GW3, Source Area Containment via Hydraulic Control/Treatment/Discharge, or Alternative GW4, Plume Remediation via Extraction/Treatment/Discharge. EPA requested an evaluation of technical impracticability based upon the fact that the active remedial alternatives in the draft Feasibility Study (FS) report were not expected to achieve remediation goals within a timeframe that is reasonable given the particular circumstances of the site. The TI justification is based on: 1) the difficulty in extracting contaminated groundwater from the site, particularly from the overburden aquifer; 2) the extremely long time frame estimated to remediate the groundwater contaminants at the site to achieve ARARs; 3) the low mobility of groundwater contamination due to the hydraulic characteristics of the aquifers; and 4) the relatively high capital and Operation and Maintenance (O&M) costs for implementation of Alternatives GW3 and GW4, when compared to the relatively low potential for long-term effectiveness. This TI waiver would be considered for the entire contaminated groundwater plume, which extends beyond the CIC property boundaries, as shown in Figure 1 and discussed in more detail below.

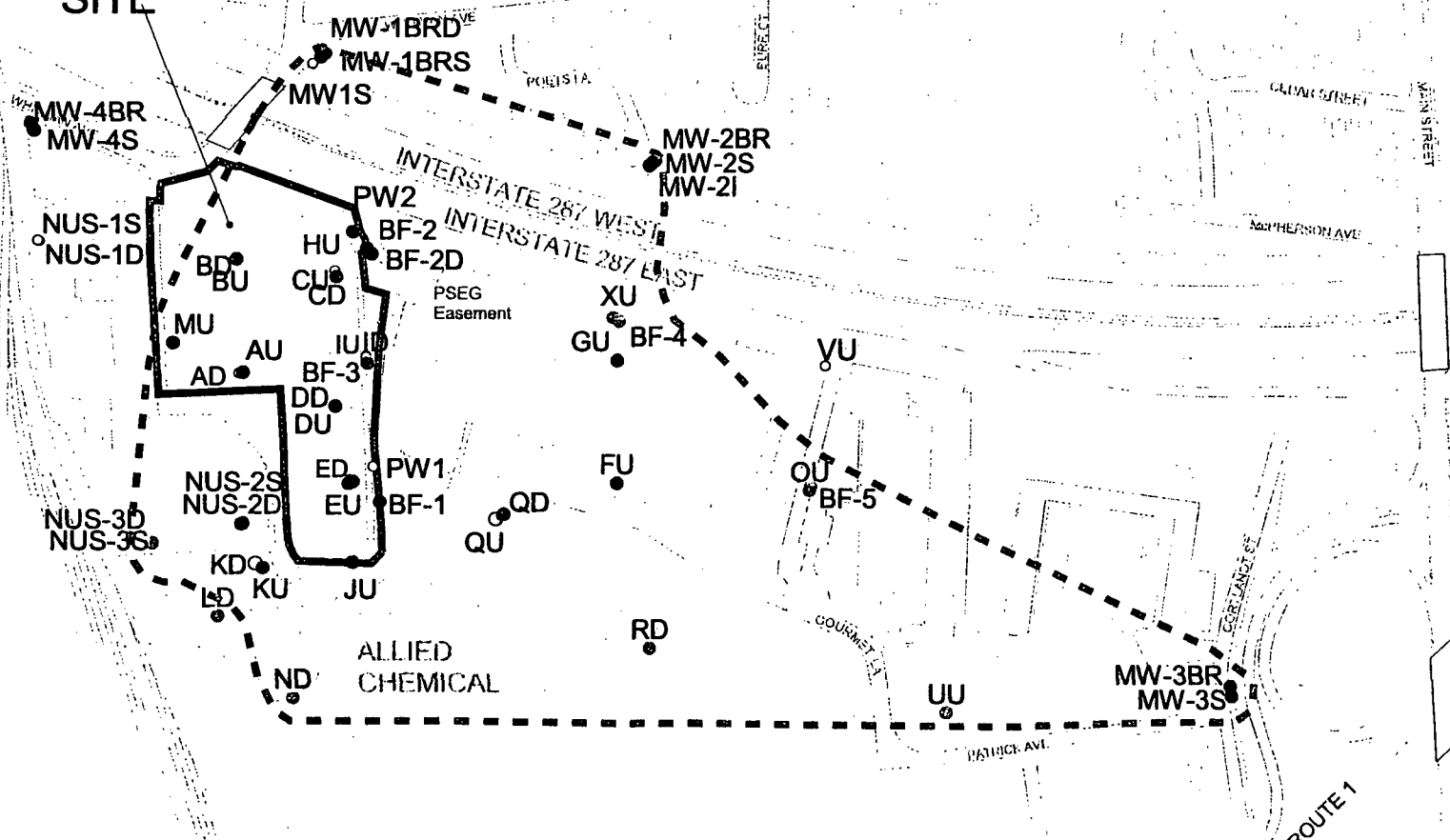
As described in EPA's September 29, 2000, Record of Decision (ROD) for OU-2 for the CIC site, EPA is addressing contaminated soil and debris that act as a potential continuing source of groundwater contamination through excavation and off-site disposal. The OU-2 remedy includes excavating contaminated soils and debris, with dewatering to allow excavation below the water table. While the OU-4 FS evaluated only groundwater remedies, the effectiveness of any groundwater response will be greatly enhanced by the OU-2 remedy. In fact, the OU-2 remedy is expected to have a more profound affect on the groundwater contamination than the active remedial alternatives considered in the OU-4 FS.

## 2.0 SITE BACKGROUND

The CIC site is located at 30 Whitman Avenue in Edison Township, Middlesex County, New Jersey. The 5.5-acre site is bounded on the north by Interstate 287. Between the site and Interstate 287 is a steep grade (35 to 40 feet high) which slopes down from the site to the roadbed of Interstate 287. East of the property is a 35-foot wide Public Service Electric and Gas (PSEG) easement. Just beyond the PSEG easement is a steep grade (10 to 15 feet high), which slopes down to an active commercial property owned by Metroplex Corporation. To the south is another steep grade (approximately 10 to 15 feet high) which slopes down to a railroad spur owned by Conrail and a vacant industrial property formerly owned by Allied Chemical Company, now known as Honeywell Corporation. West of the CIC property fence (and at approximately the same elevation) is a vacant industrial property.

The site is presently unoccupied, and had previously been the location of a pesticide, insecticide, and herbicide formulation facility. The site is completely fenced (chain-link) and covered almost in its entirety by an impermeable cap. The cap system, installed as part of the OU-1 remedy, consists of an exposed chlorosulfonated polyethylene (CSPE) geomembrane liner placed on top of a geotextile material. With the demolition of the CIC plant facilities in 1975, the only structures remaining on-site prior to the installation of the cap were remnant building foundations, flooring, and bituminous asphalt roadways.

CIC  
SITE



- Well not sampled 1998-99
- Well sampled during the 1998 investigation
- Well sampled during the 1999 investigation
- Well sampled during the 1998 and 1999 investigations
- - Estimated Extent of TI Waiver

U.S. ENVIRONMENTAL PROTECTION AGENCY  
Chemical Insecticide Corporation Superfund Site

Figure 1  
Estimated Extent of TI Waiver

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Source: Base Map from GEOD Photogrammetric Sciences Survey Technologies

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Additional remedial activities are planned for the CIC site as part of OU-2, which addresses contaminated soil on the CIC property and neighboring properties. A Record of Decision (ROD) for OU-2 was issued on 29 September 2000, and the selected remedy called for the excavation and off-site disposal of contaminated soil. The OU-2 Remedial Design (RD) was completed in 2002. The quantity of contaminated soil to be excavated as part of the OU-2 remedy is currently estimated to be over 150,000 cubic yards (cy), and includes excavation of soils with contaminant concentrations in excess of risk-based cleanup criteria as well as the New Jersey Impact to Groundwater Soil Cleanup Criteria (IGWSCC) to depths up to 20 feet below the existing ground surface. Some of the contaminated groundwater at the site will also be extracted and treated as a result of dewatering activities necessary to facilitate excavation of soils beneath the water table.

## **2.1 ARARs and Cleanup Criteria**

Both federal and state chemical-specific ARARs for groundwater were identified in Table 3-4 of the FS report. New Jersey groundwater regulations are considered applicable for the remediation of groundwater at this site. Federal and State primary drinking water regulations are considered to be relevant and appropriate for consideration of the groundwater. Site groundwater is classified as Class IIA, a drinking water resource, by New Jersey. It should be noted however, that there are no potable wells in the area of groundwater contamination, and the site groundwater contamination does not threaten any existing potable well. Based upon a well survey of the area, the nearest municipal well is approximately two miles upgradient (southwest) of the site.

## **2.2 Spatial Area Over Which TI Waiver Would Apply**

The TI waiver would apply to areas where site contaminant concentrations exceed MCLs. The area is approximately 50 acres, as shown on Figure 1, and includes the former CIC facility property, portions of the Metroplex and Total Tec properties, and areas under Route 287 to the north of the site. The vertical extent of groundwater contamination is relatively well understood, based upon clusters of wells in a number of locations. As discussed in more detail below, the TI waiver would include areas of overburden groundwater and bedrock groundwater. The maximum depth for which this ARAR waiver would apply would be approximately 85 feet below ground surface (bgs) in the bedrock in the north, and 35 feet bgs in the overburden in the south.

As discussed in more detail below, levels of volatile organic compounds (VOCs) detected in monitoring well BF-5 are unlikely to be as a result of the CIC site. This contamination was discovered during investigations at the CIC site, and it is being included in the area of the TI evaluation waiver, because the technical background evaluated for the TI evaluation is also relevant to this potentially separate area of contamination. This ARARs waiver would not preclude a separate source remedy, if such a source were to be identified in the future.

## **3.0 CONCEPTUAL MODEL**

The RI/FS report provides a comprehensive description of the site. The original CIC operation resulted in an area of soil contamination from indiscriminate dumping, unlined lagoons, and septic discharges. Downward contaminant migration resulted in an area of overburden soils contaminated with a wide variety of organic and inorganic contaminants. Overland flow, through site run-off and discharge through more conventional drainage channels, resulted in off-site migration of contaminants to the east, eventually reaching downgradient surface water discharges to the Raritan River (the remediation of these down-gradient surface waters was the subject of the OU-3 site remedy). As identified in Figures 1-5 through 1-8 of the FS report, the primary direction of these overland flow pathways was to the east, parallel to Route 287. Groundwater contaminant migration appears to be significantly influenced by these overland flow routes; the degree of



direct contaminant migration in the groundwater appears to be limited to one area of the site, the bedrock in the northeast, on or relatively near the site, corresponding to monitoring wells BF-2, BF-3, HU, PW-2, and BD. In this area of the site, the bedrock is relatively close to the surface (within approximately 16 feet of ground surface in some areas), and this proximity of the bedrock to the areas of high soil contamination has resulted in very high contaminant concentrations in the bedrock in this area. Contaminant migration in the area occurs at a very slow rate, both vertically and horizontally. This is illustrated by the steep concentration gradients with depth, as well as in the direction of horizontal flow, to the east and northeast.

### 3.1 Site Geology

Four stratigraphic units were encountered during drilling on the site and neighboring properties:

- 1.01 Fill materials (Unit I);
- 1.02 Fluvio-glacial deposits (Unit II);
- 1.03 Weathered Bedrock (Unit III); and
- 1.04 Bedrock (Unit IV).

#### 3.1.1 Fill Materials

Fill material varies in thickness from 0 to 12 feet under the site. The fill is composed predominantly of medium to coarse sand with subordinate amounts of gravel, silt, and clay, and minor amounts of debris. This unit has been designated as Unit I.

#### 3.1.2 Fluvio-glacial Deposits

Fluvio-glacial deposits of the Pennsauken Formation, consisting of a heterogenous mix of gravel, sand, silt and clay, designated as Unit II, underlie the Unit I fill. The thickness of this unit throughout the site and surrounding properties ranges from 2 feet at well BF-5, east of the Metroplex building, to more than 35 feet at well ND, west of the Allied Chemical property. Generally, these deposits consist of fine to medium sand and silt with numerous, discontinuous stringers and lenses of gravel and clay. The thickness of the fluvio-glacial deposits is significantly greater in wells BF-1 and BF-4, which are located on the eastern side of the site and further east on the Metroplex property, respectively, than in the surrounding monitoring wells. This thicker deposit may indicate the presence of a channel-fill deposit eroded into the Unit III deposits as described below, and filled with silt, clay, sand, and gravel typical of Unit II during an interglacial period. The Unit II sediments deposited in this area exhibit the bedding structures indicative of a channel deposit.

#### 3.1.3 Weathered Bedrock (saprolite)

Below Unit II are deposits of red clay and silt with subordinate amounts of sand and gravel, designated as Unit III. Unit III is present throughout the site and surrounding properties and appears to function as a semi-confining hydrologic barrier to vertical groundwater flow. The thickness of Unit III shows considerable variation, ranging from approximately 4 feet in wells HU and BF-5 to approximately 45 feet in well BF-4. Unit III is described in the well logs as a mottled yellow-brown to brick red silty clay, stiff to very stiff, with some fine to medium-fine sand, fine gravel and coarse sand. The Unit III clay is typically red to reddish brown in color; however, greenish and light blue-gray/yellowish red-brown zones are common. The clays tend to be laminated with interbeds of yellowish-rusty silt. Near the base of Unit III, weathered shale fragments are reported. The contact between Unit III and the underlying bedrock, Unit IV, is typically transitional based upon the degree of bedrock weathering.

### 3.1.4 Bedrock

Unit IV is composed of rocks of the Triassic-aged Newark Group, of which two members are present locally: the Brunswick Formation and the Lockatong Formation. The Brunswick is the youngest formation of the Newark Group, which consists of the Stockton, Lockatong, and Brunswick Formations in the order of oldest to youngest. The Brunswick Formation consists predominantly of reddish-brown feldspathic mudstone and micaceous siltstone with some claystone and fine-grained sandstone. Depth to bedrock varies from 15 feet bgs, in well MU, to approximately 65 feet bgs in well BF-4. Most of the site is located on a bedrock high bordered to the east by a probable erosional channel scoured in the bedrock. The southern portion of the site is underlain by a bedrock low filled with low permeability sediments typical of Unit III; however, some higher permeability materials were also observed in the bedrock low during drilling, particularly near well QD. In the study area where Unit IV was encountered, it is typically described as a reddish-brown to maroon shale that is fissile, slightly weathered, with varying degrees of horizontal fracturing. Grayish-white flecks were commonly observed. Approximately 4 feet of a greenish-blue shale was also observed during the drilling of well BF-3.

### 3.2 Site Hydrogeology

In general, the hydrogeology in the study area consists of two separate regimes, an unconfined overburden zone (Units I and II), and a partially confined, fractured bedrock water-bearing zone (Unit IV), separated by a leaky confining layer (Unit III). However, based on observations during drilling, hydrostratigraphic units appear to cross stratigraphic boundaries. Both Units II and III are highly heterogeneous and locally discontinuous. Localized fine-grained zones within the generally sandy Unit II tend to impede groundwater flow and have hydrogeologic characteristics that resemble Unit III. Likewise, sandy zones within Unit III are behaviorally more similar to Unit II. Based on these observations, the following hydrostratigraphic units are contained in the study area:

- Unconsolidated groundwater zone – comprised of Units I, II and sandy zones within Unit III;
- Leaky confining zone – comprised of low permeability silt/clay units within Units II and III; and
- Bedrock aquifer – comprised of water-bearing fractured bedrock of Unit IV.

Wells screened in the unconsolidated groundwater zone exhibited static groundwater levels ranging from less than 5 feet bgs in well XU, to nearly 17 feet bgs in well CD. Wells screened within the bedrock aquifer exhibited static groundwater levels ranging from less than 1 foot bgs in well BF-4, to 23.7 feet bgs in well MW-4BR. The variation in depth to groundwater generally correlated with the surface topography around the CIC site, and is not considered indicative of severe groundwater gradients.

Hydraulic conductivities within the water-bearing units were initially estimated from slug tests performed in on-site and off-site wells installed during the RI. Overburden hydraulic conductivities estimated from the slug test analyses ranged from  $2.30 \times 10^{-6}$  centimeters per second (cm/sec) to  $3.20 \times 10^{-3}$  cm/sec. The average hydraulic conductivity calculated for bedrock wells was  $3.96 \times 10^{-4}$  cm/sec.

A short-term step test of the overburden indicated that the overburden could not be reliably pumped at a sustained rate of 0.5 gallons per minute (gpm); as a result, a pump test could not be performed in the overburden. A short-term step test of the bedrock was also performed, and the results indicated that a groundwater extraction rate of approximately 4 gpm could be maintained. A constant-rate pumping test of the bedrock was performed. Well PW-2, a 10-inch diameter well located in the northeastern corner of the site and screened within the bedrock aquifer, was chosen for the constant rate test. The data analysis for the constant-rate pump test resulted in an estimated average transmissivity of 111 square feet per day (ft<sup>2</sup>/d) or 830 gallons per day per square foot (gpd/ft). Using an estimated 100 feet of aquifer thickness, an average hydraulic conductivity of 1.11 ft/d or  $7.7 \times 10^{-4}$  ft/min or  $4.0 \times 10^{-4}$  cm/sec. was estimated for the bedrock. This

is comparable to the average hydraulic conductivity calculated from the slug testing ( $3.96 \times 10^{-4}$  cm/sec). Unlike the overburden, where there were essentially no prospects for sustaining groundwater extraction, the observed drawdown during the relatively short pumping test indicated that sustained pumping at a rate of approximately 4 gpm may be effective at controlling the downgradient movement of contaminants in the bedrock.

Typical horizontal hydraulic gradients measured in the unconsolidated groundwater zone ranged from 0.02 to 0.04 ft/ft. Using an average hydraulic conductivity of 4 ft/day, based on slug test data, Darcy velocities were calculated to be 0.08 to 0.16 ft/day. Assuming a porosity of 30% (Freeze and Cherry, 1979), the intrinsic groundwater velocity of the more permeable zones within the overburden ranges from 0.27 to 0.54 ft/day.

Measured horizontal hydraulic gradients in bedrock at the site range from 0.03 to 0.04 ft/ft. Darcy velocities, based on an average hydraulic conductivity of approximately 1.1 ft/day, range from 0.03 to 0.04 ft/day. Assuming a porosity of 10% for the Brunswick Shale (Freeze and Cherry, 1979), the intrinsic groundwater velocity ranges from 0.3 to 0.4 ft/day.

### 3.3 Nature and Extent of Groundwater Contamination

Groundwater contamination exists at the site in both the overburden and bedrock zones. The principal sources of the groundwater contamination appear to have been overlying contaminated soil and/or contaminant residuals from the former septic pit, former process wastewater lagoons, and former buried drum areas; the majority of the contaminant sources are planned to be removed as part of the OU-2 remedy. Wastewater discharged to the lagoons many years ago during the operation of the facility may also have contributed to the current groundwater contamination. The on-site groundwater contains contaminants exceeding screening criteria (e.g., N.J. groundwater quality criteria and MCLs, and EPA MCLs) in upper overburden, lower overburden, and bedrock. These contaminants include the following:

Pesticides	Herbicides	Metals	VOCs	SVOCs
DDD	2,4-D	Aluminum	vinyl chloride	Pentachlorophenol
DDE	Dinoseb	Arsenic	1,1-dichloroethene	2-chlorophenol
DDT	MCP	Beryllium	1,2-dichloroethene (total)	2,4-dichlorophenol
alpha-BHC	MCPA	Cadmium	cis-1,2-dichloroethene	2,4-dinitrophenol
beta-BHC		Chromium	1,2-dichloroethane	2,4,6-trichlorophenol
gamma-BHC		Iron	2-butane	4-nitrophenol
Aldrin		Manganese	trichloroethene	1,2,4-trichlorobenzene
Dieldrin		Mercury	Benzene	4-chloroaniline
heptachlor epoxide		Nickel	tetrachloroethene	
alpha-chlordane		Sodium	chlorobenzene	
		Thallium		

The most frequently detected contaminants of concern in groundwater were arsenic, benzene hexachloride (BHC) pesticides, volatile organic compounds (VOCs) and dinoseb. With the exception of VOCs, the frequency of detection for groundwater contaminants corresponded with the area of soil contamination, and substantially lower at wells further from the areas of soil contamination. The most frequently detected VOCs, trichloroethylene and tetrachloroethylene, were found at greater concentrations in several of the wells most distant from the site, suggesting an off-site source for this contamination.

A qualitative comparison of the results from several rounds of groundwater sampling indicates that, in general, the number and concentrations of groundwater contaminants decreased in the approximate three-year interval between the Phase I/II investigations (1987-1988) and the Phase III investigation (1991), and further decreased in the seven to eight years until the 1998 EPA and the 1999 Phase IV investigations. The general

decrease in contaminant concentrations for the various groundwater units is likely due to the installation of the cap system in September 1994, which limited the percolation of rainwater through the overlying contaminated media. However, in selected locations, contaminant concentrations after installation of the cap were greater than the concentrations prior to installation of the cap. Factors which may influence this increase include the following: the contaminant sources are still present at the site; there is a downward flow component for the overburden groundwater; and the groundwater is not being diluted through the introduction of percolating rainfall. In general, however, the cap system has been effective as an interim measure while EPA evaluated permanent solutions for the site.

### **3.4 Contaminant Fate and Transport**

The migration of contaminants to underlying groundwater by the percolation of rainwater through contaminated soils, former lagoon/septic pit sludges and/or potentially leaking buried drum areas was a major environmental fate and transport mechanism at the site prior to the installation of the cap system. The soil analytical data indicated that numerous organic contaminants have migrated in subsurface soil to a greater extent than expected based solely on physicochemical characteristics, resulting in areas of soil contamination deeper than the apparent areas of waste disposal. This enhanced migration for some of the organic contaminants is speculated to be due to co-solvent effects exerted by the more mobile volatile organic and phenolic contaminants. The groundwater data show that on-site migration through soil via percolating rainwater into groundwater was especially important for volatile organic compounds, phenolic compounds, phthalate esters, substituted benzenes, 4-chloroaniline, bis(2-chloroethyl)ether, pesticides, herbicides, metals, and, to a limited extent, PAHs. Subsequent to installation of the cap system, the migration of soil contaminants to groundwater directly at the site through this potential transport mechanism has been substantially reduced.

Upon entering groundwater, contaminants will migrate with the local groundwater flow until dilution and removal mechanisms such as adsorption, hydrolytic degradation (herbicides and endosulfan), precipitation, and limited volatilization result in their eventual non-detection. The local groundwater flow was generally eastward with some northeast and southeast flow components near the northern and southern portions of the site, respectively, prior to cap installation. In the vicinity of the site, a northeast flow component toward Interstate 287 exists for the overburden aquifer. Bedrock groundwater flows eastward across the site, and then southeastward. In addition, a sewer line exists that may be a preferential migration pathway for groundwater in the vicinity of the site. Vertically, contaminants have migrated to and within groundwater present in the upper fractured bedrock. The vertical extent of contamination has been largely defined, as the deepest on-site well indicated significantly reduced concentrations compared to shallower zones. In addition, although contaminants have migrated off-site laterally (contaminants have been detected in downgradient wells BF-5, UU, and MW-3S), based on concentration distributions, downgradient wells indicate contamination which may be originating from additional off-site sources, with some potential contribution from the site.

#### **3.4.1 Groundwater Modeling**

Limited groundwater modeling was performed to assess contaminant migration and evaluate potential remediation scenarios. The groundwater modeling focused only on remediation of the overburden; no modeling of bedrock contaminant migration or remediation scenarios was performed.

A groundwater modeling study was performed using FEMSEEP, a two-dimensional finite element groundwater flow model, to characterize regional groundwater flow and evaluate the hydraulics of various remediation schemes. The most aggressive remediation scheme considered in the model (i.e., the strategy that resulted in maximum flushing of groundwater through the site) was a combination downgradient French drain and upgradient recharge trench. The results of the model demonstrated that groundwater could be extracted and reinjected at a rate of approximately 50 gpm under this scenario.

An analytical flushing model was used to determine the remediation time necessary to reduce arsenic concentrations present in the overburden groundwater to the ARAR of 2.2 ug/l under the French drain/upgradient recharge trench scenario. The remediation times to reduce the maximum (53,550 ug/l), mean (4,105 ug/l) and median (13 ug/l) arsenic concentrations found in groundwater at the CIC site to an ARAR of 2.2 ug/l were estimated to be greater than 6,100 years, 4,500 years and 1,000 years, respectively, under this scenario.

#### 3.4.2 Soil Column Leaching Test

During the OU-2 RI/FS, a soil column leaching test was also conducted to estimate the time to flush groundwater contaminants from the saturated zone soils, subsequent to removal of unsaturated zone sources. The objective of this test was to evaluate the effectiveness of excavating contaminated soil only to the depth of the water table, and addressing residual soil contamination through various groundwater remediation methods. The soil column leaching test results indicated a time frame of between 214 to 1,802 years to flush all pesticides in the saturated soils to levels below ARARs, after removal of the unsaturated zone sources. Considering the results of this soil column leaching test, EPA elected to evaluate, and eventually selected, a source control remedy that entails excavating soil source areas from both the unsaturated and saturated zones, to depths up to 20 feet bgs. Consequently, the soil column leaching test results are no longer applicable for prediction of remediation time frames; however, this information is still relevant for this TI evaluation, because it does provide a qualitative assessment of the potential groundwater treatment time frames for the overburden at the site.

### 4.0 **SITE REMEDIATION POTENTIAL**

Based on the site characteristics, contaminant fate and transport analysis, nature and extent of contamination, groundwater modeling and the soil leaching study, and with due consideration of the remedial activities currently planned for the site as part of OU-2, the following engineering analysis of the potential to remediate contaminated groundwater at the site was performed.

#### 4.1 **Containment or Removal of Contaminant Sources to the Extent Practicable**

As described in EPA's September 29, 2000 Record of Decision (ROD) for OU-2, EPA is addressing contaminated soil and debris at the CIC site through excavation and off-site disposal. At the completion of the OU-2 remedy, soil contamination that could potentially serve as a continuing source of groundwater contamination will have been addressed to the extent practicable, as the remediation goals for deeper soils are based upon NJDEP's impact to groundwater criteria.

The hydraulic characteristics of the site soils may be altered by implementation of the OU-2 remedy. However, deeper overburden soils which are not excavated under the OU-2 remedy (i.e., greater than 20 feet bgs), as well as soils around the perimeter of the excavation, will approximately maintain their current hydraulic characteristics. Since the hydraulic characteristics of these soils will be unchanged, the inability to flush contaminants from these soils (i.e., the inability to substantially increase the groundwater flow rate in the overburden), as demonstrated in the groundwater model, will persist.

The removal of contaminated soil, both in the unsaturated and saturated zones, as part of the OU-2 remedy, will significantly reduce, if not eliminate, the migration of contaminants from soil to groundwater. A substantial volume of the most contaminated on-site groundwater will be removed as a result of the OU-2 excavation and dewatering activities; some flushing of contaminants from adjacent soils may also result from dewatering activities.

## 4.2 Analysis of the Performance of Ongoing or Completed Remedial Actions

OU-1 The OU-1 remedy (the interim cap and surface water drainage enhancements), discussed above, will be removed as part of the OU-2 source control remedy, and will not be a factor in any long-term groundwater remedy. Analysis of the groundwater contamination over time indicated that the interim remedy, completed in 1995, slowed the off-site migration of contaminants in the groundwater.

OU-2 The OU-2 remedy was discussed above.

OU-3 The OU-3 remedy, the remediation of contaminated sediments in off-site creek channels, is not expected to be a factor in any future groundwater remedy. The OU-3 remedy was performed after completion of the OU-1 remedy (i.e., after the potential for additional surface run-off from the site to contribute to additional off-site sediment contamination was mitigated), and post-remedial sampling has indicated that the OU-3 area remains free of contamination. Based upon the groundwater flow patterns predicted in the RI report, groundwater contamination is not expected to discharge to this or any other surface water body.

## 4.3 Predictive Analyses of Time Frames to Attain Cleanup Levels using Available Technologies

Based upon the previously discussed limited groundwater modeling, soil column leaching test, aquifer tests, and potential changes in the overburden that may take place as a result of the OU-2 remedy there is very little remediation potential for the overburden groundwater. Pumping of the bedrock aquifer from multiple locations at a sustained rate of up to 4 gpm at each location may be possible based on the aquifer testing. At this extraction rate, hydraulic control can be maintained to prevent further off-site migration of contaminated groundwater. In addition, extraction of contaminated groundwater would reduce the overall contaminant concentrations over time to some degree. However, cleaning up the bedrock to ARARs does not appear to be possible, even with pumping at the most aggressive levels achievable, due to the following:

- The volume of water that can be withdrawn from the unit is low due to its relatively low conductivity;
- Remedial efforts would be driven by very high arsenic concentrations. As arsenic is not a very soluble contaminant, elevated concentrations will persist for a very long time as it slowly partitions into the groundwater; and
- Remediation of fractured bedrock is known to be very difficult, as residual contaminants will likely remain in dead-end fractures within the rock.

The benefits to groundwater quality from source removal as part of OU-2 will likely be much greater than the impact of removing small amounts of contaminants through low level pumping. Natural attenuation also does not appear to be applicable at the site, since there is a complex suite of contaminants present, which require different geochemical conditions to degrade or drop out of solution.

Although the MCLs are not expected to be achieved in a timeframe that is reasonable given the particular circumstances of the site, groundwater contaminants are not expected to measurably impact human health or the environment. While the groundwater at the site is considered Class IIA, a potable water resource, the bedrock groundwater in the area of the site is not highly conductive and is an unlikely candidate for future use as a resource. The nearest public supply wells are approximately two miles southwest, and upgradient, of the site. A well survey has not identified any potable wells in use at or downgradient of the site.

#### **4.4 Demonstration that No Other Remedial Technologies Could Attain Cleanup Levels at the Site within a Reasonable Time Frame**

The FS reports for contaminated soil (OU-2) and contaminated groundwater (OU-4) present a thorough analysis of the technologies evaluated to address groundwater contamination, including containment technologies, in-situ technologies, and extraction and treatment. Groundwater technologies were evaluated to attempt to address the OU-2 soil contamination at the site; EPA ultimately elected to remove the soil source area, because no other remedy was deemed to be adequately protective of the groundwater.

#### **4.5 Economic Assessment**

The capital cost for Alternative GW3 is estimated to be \$2,581,000. The annual O&M cost is estimated to be approximately \$424,000. The present worth, based on a 30-year period and a discount rate of seven percent, would be approximately \$7,840,000.

The capital cost for Alternative GW4 is estimated to be approximately \$3,847,000. The annual operation and maintenance cost is estimated to be approximately \$523,000. The present worth, based on a 30-year period and a discount rate of seven percent, would be approximately \$10,340,000.

For the purpose of developing, evaluating, and comparing remedial alternatives, a 30-year remediation time frame is typical. However, since ARARs are not expected to be achieved within this time frame, the following cost impacts should also be considered:

- The groundwater extraction and treatment systems, for both Alternatives GW3 and GW4, would need to be replaced approximately every 30 years, at estimated costs of \$2,581,000 and \$3,847,000 (year 2002 dollars), respectively, based on an estimated equipment design life;
- O&M costs of approximately \$424,000 and \$523,000 (year 2002 dollars) for Alternatives GW3 and GW4, respectively, would be incurred annually for the entire remediation time frame; and
- A seven percent discount rate, inclusive of inflation and return on investment, may not be valid for the entire duration of the remediation.

Due to the time value of money, a present worth analysis beyond the 30-year analysis time frame does not typically indicate a substantially higher net present worth (maximum values of \$9,030,000 for GW3 and \$11,900,000 for GW4 for extremely long remediation time frames and a 7% net return on investment). However, lower return rates, as are currently being experienced, could substantially increase the net present worth of these alternatives. For example, should net returns over the long-term remediation average 1% (instead of 7%), the net present worth of Alternatives GW3 and GW4 would increase to approximately \$13,520,000 and \$17,340,000, respectively, for the 30-year time frame.

#### **4.6 TI Summary**

The factors that warrant the decision to declare groundwater restoration to achieve ARARs as technically impracticable include:

- The limited options available to successfully extract and treat groundwater contamination in the overburden and fractured bedrock units at the site, due to low hydraulic conductivities, preferential flow pathways, and the non-homogeneous nature of both aquifers;
- The limited mobility of the groundwater contamination in the overburden and bedrock, due to low hydraulic conductivities and sorptive capacity of the aquifer materials;

- The potential time frame of hundreds to thousands of years to actively remediate the contaminated groundwater;
- The potential that source removal during the OU-2 remedy will do more to reduce contaminant concentrations than any active groundwater remediation; and
- The high present worth cost for groundwater containment (GW3) or restoration (GW4), as well as the need to replace the treatment system approximately every 30 years for the entire duration of the remediation, based on the typical design life of process equipment.

## 5.0 ALTERNATIVE REMEDIAL STRATEGY

As discussed previously, Alternatives GW3 and GW4 are not viable strategies for achieving ARARs or remediating groundwater at the site within a reasonable time frame. A waiver from achieving ARARs is warranted. The alternative strategy is the implementation of Alternative GW-2 – Monitoring/Institutional Controls. A long-term monitoring plan would be developed and implemented at the site. Sampling would be geared towards monitoring the boundaries of the contaminated area, as well as areas with the highest levels of contamination. This will provide assurance that there continues to be no impact to human health via plume migration, as well as data on the positive impacts of source removal.

Alternative GW-2 is protective of human health, since it provides long-term control of the (currently incomplete) groundwater exposure pathway and, through institutional controls such as a Classification Exception Area (CEA) instituted by NJDEP, would prevent future use of the groundwater within the CEA. Following implementation of the OU-2 remedy, and Alternative GW-2, if potential “triggers” signal that this remedy is not performing satisfactorily, a re-evaluation of options and the development of an alternative strategy to mitigate these impacts would need to be performed. The criteria that signal unacceptable performance of the selected remedy and indicate when to implement contingency measures, include:

- Contaminant concentrations in groundwater at specified locations exhibit an increasing trend not originally predicted during remedy selection;
- Future monitoring indicates unacceptable impacts to sediments or surface water;
- Near-source wells exhibit concentration increases indicative of a new or renewed release;
- Contaminants are identified in monitoring wells located outside of the original plume boundary;
- Contaminant concentrations are not decreasing at a sufficiently rapid rate to meet the remediation objectives; and
- Changes in groundwater use will adversely affect the protectiveness of the remedy.

The alternative remedy is based on the current data and is subject to change based on future data that may be collected and demonstrate differing conditions. Five-year reviews, as required by CERCLA, also serve to evaluate whether conditions differ sufficiently from those expected to merit a re-evaluation of alternatives.



## 6.0 REFERENCES

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